A Microwave SAGE Experiment

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Overview

- Fly existing ISS SAGE III and a microwave (MW) radiometer on same platform to make simultaneous solar occultation measurements.
  - Preliminary orbit parameters:
    - Altitude: 500-550 km
    - Inclination: 56°
- First space-based MW solar occultation experiment.
- Utilize a 3 x 1.5 meter MW antenna that will provide ~1.5 km vertical resolution per measurement.

Overview

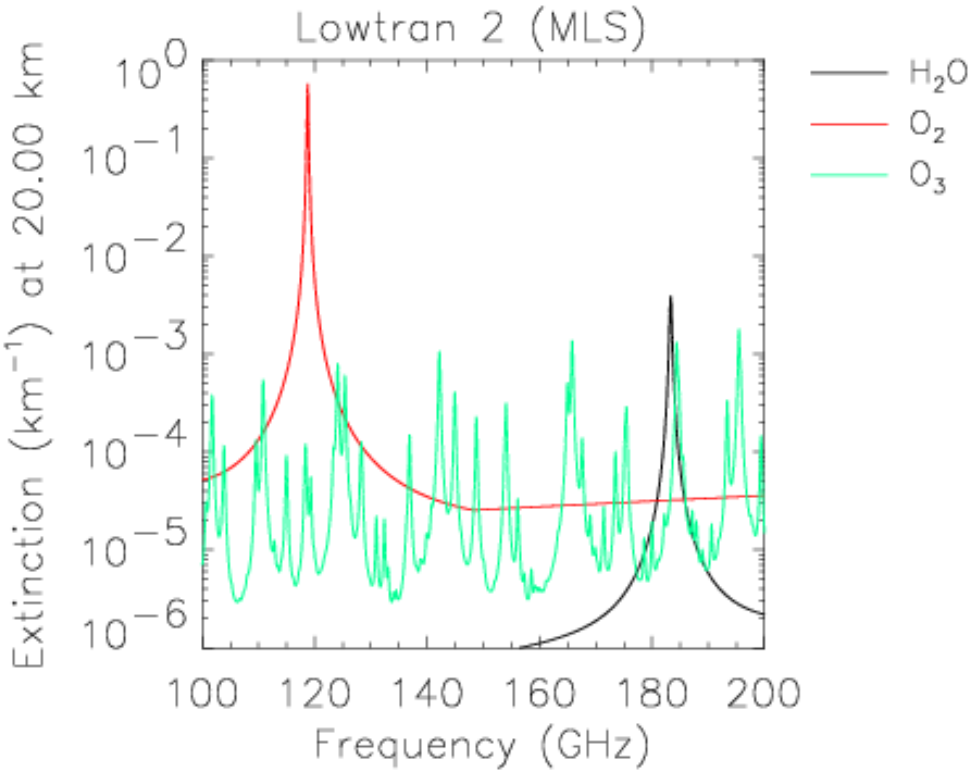
- MW measurements used to retrieve profiles in stratosphere and upper trop
  - Water vapor
  - Ozone
  - Temperature
  - Water isotopes ($H_2{}^{18}O$ and HDO)

- MW retrievals quite independent of SAGE III retrievals. Thus, they can be combined to enhance overall accuracy.

Overview

- MW limb emission and SAGE III limb scattering observations can be made between solar occultations to:
  - Substantially increase data coverage (common criticism of solar occultation experiments)
- Additional nadir scanning MW radiometer may allow 2-D tomographic retrievals of water vapor and ozone distributions

- Atmospheric extinction at 20 km for mid-latitude summer conditions.
- Measurements near 118.75 GHz O_2 line will be used for temperature.
- Measurements near 183.31 GHz H_2O line for water vapor.
- Strongest O_3 line centered at 195.43 GHz.



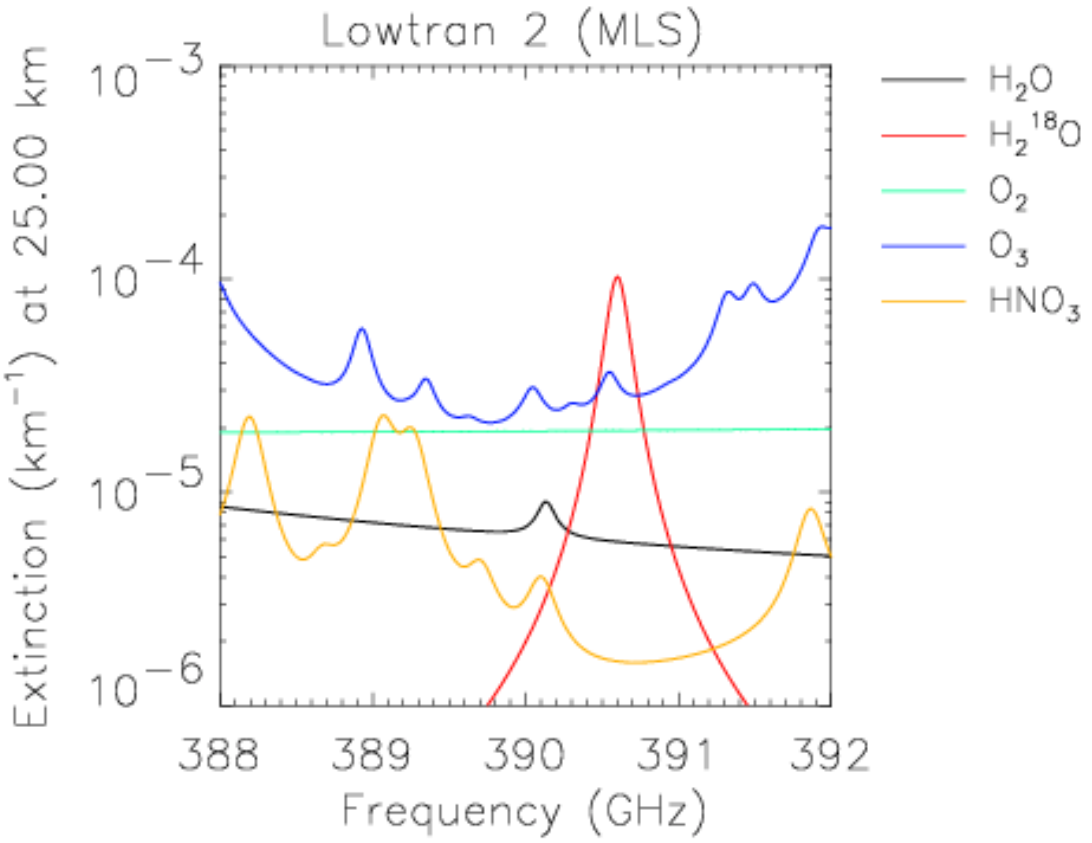
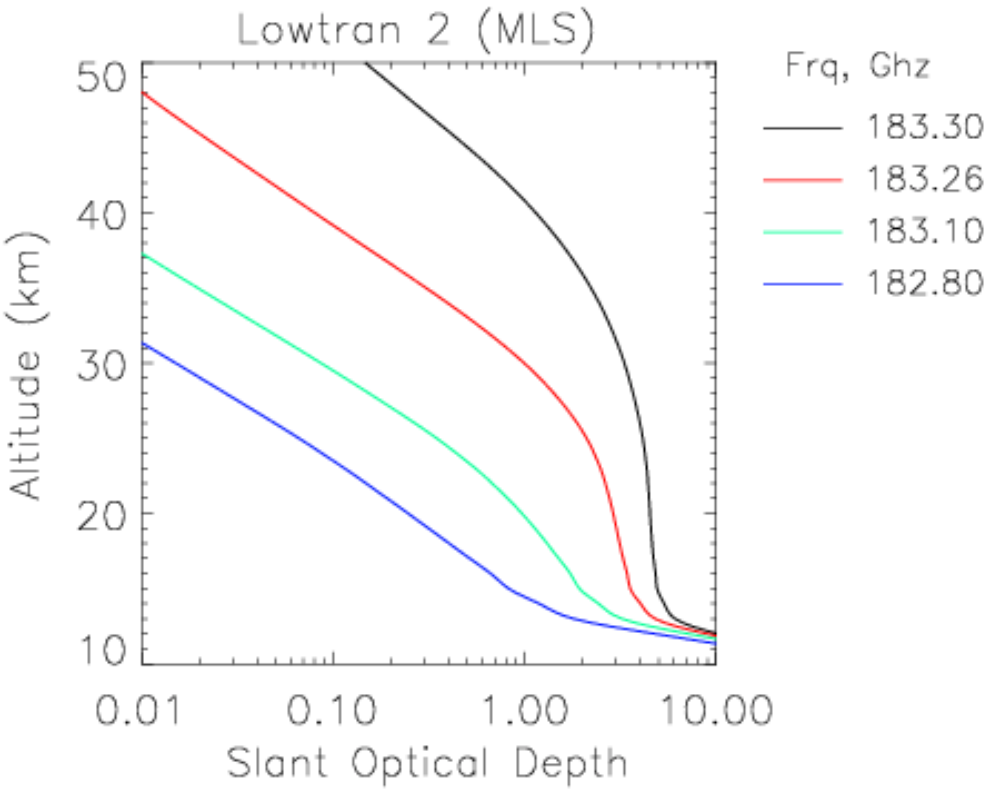


Figure showing the possibility of retrieving the $H_2{}^{18}O$ isotope by measuring extinction near the 390.60 GHz line.

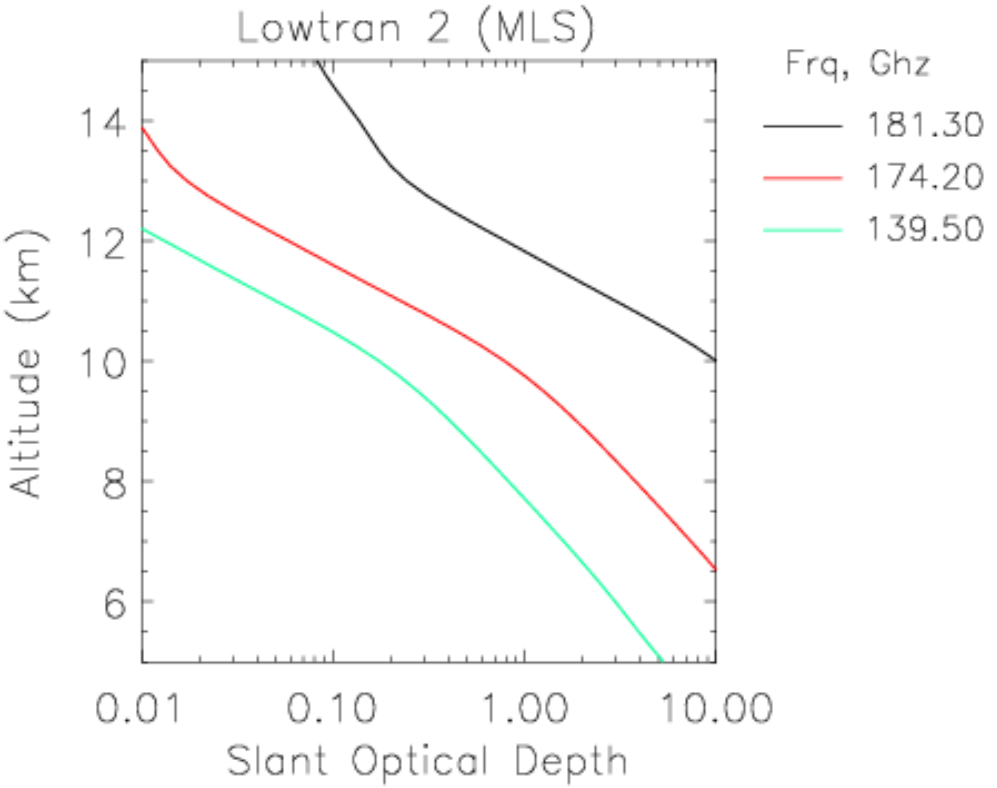
Stratospheric Water Vapor

- Total slant path optical depth at selected frequencies throughout the stratosphere.
- Most of the extinction is due to absorption by water vapor.



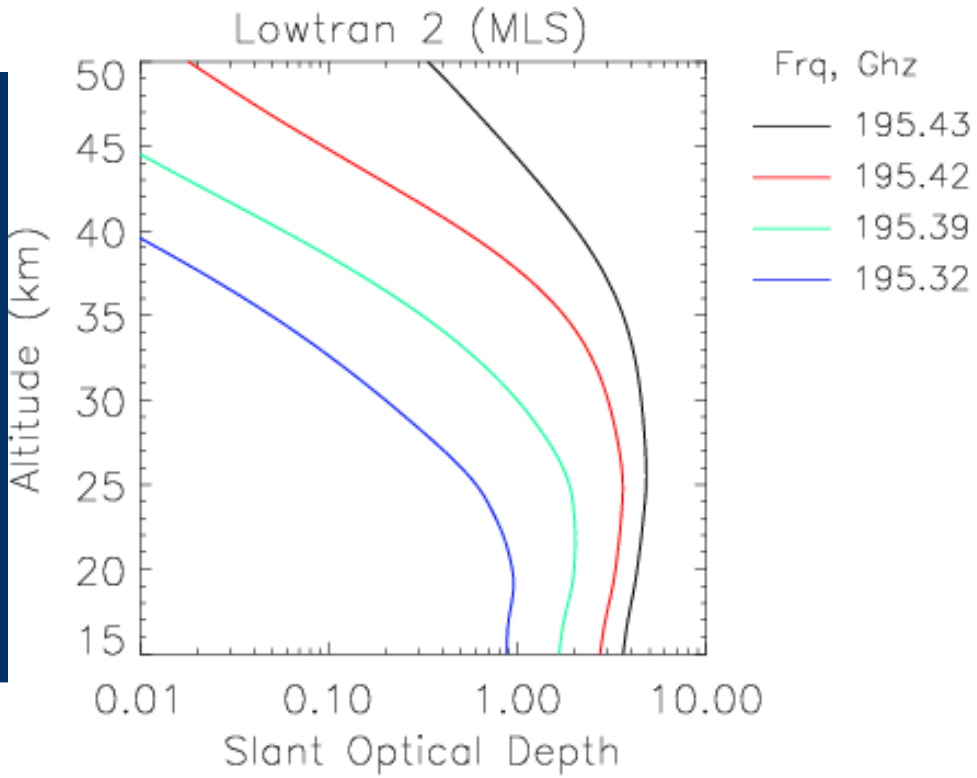
Upper Trop. Water Vapor

- Total slant path optical depth (SPOD) for selected frequencies throughout the upper troposphere.
- Where SPOD ~1, most of the extinction is due to absorption by water vapor.



Stratospheric Ozone

- Total slant path optical depth at selected frequencies throughout the stratosphere.
- Most of the extinction is due to absorption by ozone.



Advantages

- Solar occultation method is well suited for long-term monitoring of trends.
  - Other satellite monitoring techniques cannot match its combination of stability and vertical resolution.
- Proposed experiment allows continuation of the SAGE data series.
- Additional MW measurements are better suited to recover accurate water vapor and temperature profiles than existing SAGE wavelengths
  - Could potentially be used to verify and “back-calibrate” previous SAGE retrievals.

Other Advantages

- In solar occultation mode we expect much improved accuracy over MW emission sounders.
  - Transmission is much less temperature dependent than emission
    - Makes retrievals less susceptible to temperature uncertainties.
  - Received power in solar occultation mode is 1-2 orders of magnitude greater than limb emission.

Advantages (concluded)

- MW frequencies will penetrate thin cloud layers, allowing more frequent retrievals into the troposphere.
- Determination of trends in upper tropospheric and lower stratospheric water vapor is critical to understanding climate changes.
- Water isotope profiles can be used as tracers for diagnosing transport and dehydration mechanisms.